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Science Advisory Report 2014/029

ASSESSMENT PROTOCOL FOR COMMERCIAL HARVEST OF PACIFIC OYSTERS (*CRASSOSTREA GIGAS*) IN BRITISH COLUMBIA

Photo: Tammy Norgard, Fisheries and Oceans Canada

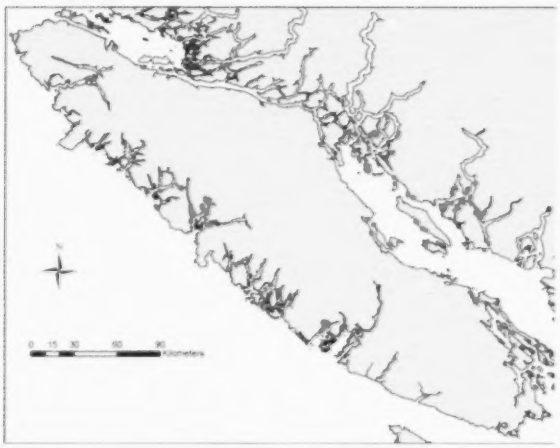

Figure 1. Map of past harvest locations of Pacific Oyster Fishery

Context:

Pacific Oysters were brought to British Columbia (BC) in 1912 or 1913 and have been cultured and harvested since. Establishment of wild populations led to development of a commercial fishery in the 1940s that continues to the present. The Provincial government was responsible for management of this commercial fishery until 2012, when a legal decision resulted in responsibility shifting to the federal department Fisheries and Oceans Canada.

This review was held in response from a request from fisheries management to develop an assessment protocol for the commercial harvest of Pacific Oysters (Crassostrea gigas) in British Columbia

This Science Advisory Report is from the December 4, 2012 review of the Assessment Protocol for Commercial Harvest of Pacific Oysters (Crassostrea gigas) in British Columbia. Additional publications from this meeting will be posted on the Fisheries and Oceans Canada (DFO) Science Advisory Schedule *as they become available.*

SUMMARY

- Pacific Oysters were brought to BC in 1912 or 1913 and have been cultured and harvested since. Successful reproductive events in the 1940s, 1950s and 1960s resulted in the establishment of Pacific Oyster throughout the Strait of Georgia. Subsequent transplants resulted in the establishment of wild populations in suitable habitats on the west coast of Vancouver Island.
- Establishment of wild populations led to the development of a commercial fishery in the 1940s that continues to the present. The Provincial government was responsible for management of this commercial fishery until 2012, when a legal decision resulted in responsibility shifting to Fisheries and Oceans Canada.
- An evaluation of the stock assessment framework utilized by the BC Ministry of Agriculture (BC MoA) to determine harvest options for the for the wild oyster fishery was conducted and advice is provided respecting a new Pacific Oyster stock assessment protocol, for use by the Fisheries and Oceans Canada (DFO).
- Field studies were undertaken to develop a statistical basis for the survey protocol used to quantify Pacific Oyster biomass on a beach
- The recommended Pacific Oyster Stock Assessment Framework consists of a statistically-based stratified random sampling survey design, with an optimal quadrat size of no less than 75x75 cm, a sampling intensity of 10 quadrats per hectare, and a minimum sample size of 5 quadrats per stratum.

INTRODUCTION

Pacific Oysters are a non-native species that was introduced to BC in the early 1900s and have been cultured and harvested ever since that time. Successful reproductive events in the 1940s and 1960s resulted in the establishment of Pacific oysters throughout the Strait of Georgia (Bourne 1979). Oysters were then transported to the west coast of Vancouver Island resulting in the establishment of wild populations in suitable habitats. Successful reproduction outside of stocked tenures provided opportunity for a wild (non-cultured) fishery in the 1940s (Bourne 1979, IEC International 2006).

In 1912, the Dominion of Canada delegated responsibility for oyster harvests to the Province of B.C. In December 2010, Justice C.E. Hinkson ruled on a petition before the BC Supreme Court. The ruling concluded that aquaculture (with the exception of marine plant cultivation) was by definition, a fishery rather than agriculture; therefore management and regulation became Federal rather than Provincial jurisdiction. Although not explicitly addressed in the Hinkson decision, wild oyster harvest is a 'fishery' and belongs under Federal jurisdiction as per the pith and substance of the Hinkson decision.

The provincial government did not have a published management plan for the Pacific Oyster fishery, but followed the general objectives and order of activities listed below:

- Provincial staff selected beaches for harvest from a list of known beaches with high densities of Pacific Oysters; they completed pre- and post-season assessments if possible, and calculated a biomass for those beaches.
- Provincial staff provided harvesters a list of beaches for which application could be made (additional applications were submitted by harvesters wishing to include new locations).

- Successful applicants would apply and then be allocated an individual quota of 1 to 10 tonnes per fisher, per beach. In general, Provincial staff set harvest rates between 10 and 14% of the estimated biomass.

Since gaining jurisdiction for the fishery, one of DFO's first priorities has been to undertake development of a stock assessment protocol to ensure that accurate and standardized stock information is collected. This information can then be utilized by DFO to provide information in support of fishery management and to develop sustainable harvest strategies for specific beaches.

This assessment evaluated the assessment and management framework utilized by the BC Ministry of Agriculture (BC MoA) for the wild oyster harvest and proposes a new Pacific Oyster assessment protocol for use by the Fisheries and Oceans Canada (DFO) and Industry as DFO assumes responsibility for management and regulation of the fishery.

ASSESSMENT

Sampling Design

Intertidal assessment methodology for bivalves has been well established in BC. Stratified random sample survey designs (Gillespie and Kronlund 1999) are used to assess Manila Clam stocks and Stratified two stage survey designs are used to assess Olympia Oysters (Norgard *et al.* 2010).

Pacific Oysters generally form defined beds of single individuals or loose assemblage of clusters on the surface of the beach. However, at times high densities of individual oysters have been observed on hard substrate (large rocks or bedrock) or on vertical surfaces. Because this fishery has historically focused its effort on high density beach populations, this study recommended a Stratified random sample designs as the best survey method to attain accurate biomass estimates. This methodology was chosen because it works well when assessing fairly discrete beds with consistent density.

Quadrat Size and Sample Size

To assess optimal quadrat size and sample size, four different quadrat sizes were evaluated (25x25 cm = 0.0625 m^2, 50x50 cm=0.25 m^2, 75x75 cm = 0.5625 m^2 and 100x100 cm = 1 m^2), using a nested quadrat experiment conducted at Shack Island and Neck Point in Nanaimo BC, during low tides in summer 2012. Based on the results of this study, the densities calculated using a 75x75 cm quadrat had lower levels of variance, were less influenced by the small scale patchiness in distribution of oysters and were not as influenced by edge effect bias.

Two methods to determine the optimal sampling intensity for Pacific Oyster surveys were tested. Precision estimates were calculated using the Elliot's (1977) index of dispersion (Method 1) and sample size estimates from Quinn and Keough (2002; Method 2). In the analysis of the survey data with methods 1 and 2, it was determined that to obtain a precision of approximately 30% on discrete beds a sampling range of between 6 and 14 quadrats per strata would be required when using a 75 cm x 75 cm quadrat size and a range between 4 and 11 quadrats per strata would be required when using a 100 cm x 100 cm quadrat size. A survey precision of 30% for Manila Clam surveys has produced reliable estimates of abundance, therefore it was determined an acceptable level of precision for Pacific Oyster abundance estimates (Tammy Norgard, Fisheries and Oceans Canada, Nanaimo, BC, unpublished data).

From these results, a sampling intensity of 10 samples per hectare, with a minimum sample size of 5, is recommended for discrete beds with moderate to high density, to achieve a survey precision of approximately 30%. Sample sizes larger than 10 are encouraged if economically

and practically feasible, because increased precision will increase confidence in biomass estimates.

Sources of Uncertainty

Below is a list of uncertainties associated with the assessment of Pacific Oysters in BC.

- There is uncertainty about how applicable the Nanaimo area surveys are to the locations where the actual commercial fishery occurs.
- The presented method of surveying may function differently for varied habitat types, spatial distributions or harvesting purposes. Differing harvest purposes such as harvesting for seed stock compared with straight to market may require modified survey designs to obtain accurate estimates of biomass for the desired product.
- Lack of published information results in knowledge gaps on life history parameters of wild populations of Pacific Oysters; including age, recruitment patters, mortality and growth.
- Overall stock distribution for BC has not been assessed.
- The assessment method presented surveys within specific survey strata boundaries only, and does not provide population estimates outside of this strata.

CONCLUSIONS AND ADVICE

- Stratified Random Sampling survey methods should be used on relatively high-density discrete beds. Different habitat types, spatial distributions of animals or harvesting purpose, such as harvesting for seed stock compared with straight-to-market harvests, may require differing sampling designs and these would need to be further explored.
- A quadrat size of no less than 75x75 cm is recommended. This will help reduce variance while maximizing cost effectiveness.
- A sampling intensity of 10 quadrats per hectare with a minimum sample size of 5 quadrats per stratum is recommended. This sampling intensity should achieve approximately 30% precision and will be reviewed as more survey results become available.
- Development of a formal survey manual for Pacific Oyster surveys based on this advice is recommended. The development of a manual will assist potential harvesters in conducting surveys and data collection of wild Pacific Oysters and give guidance on sampling and data collection methodology, optimal quadrat size and sampling intensity for discrete oyster beds. The development of a manual will also ensure that accurate and standardized stock information is collected so that it can then be utilized by DFO for analysis and the provision of stock advice in the short term and sustainable harvest strategies for specific beaches in the long term.
- Future work on obtaining information on the population dynamics of the wild Pacific Oyster population in BC would help to form a better understanding of this species. Also, projects to determine the age of oysters using shells or ligaments would provide a better understanding of age composition, recruitment and mortality rates (and thus a more sophisticated approach to determining acceptable harvest rates). Over the longer term, this work could allow development of age-based assessments of oyster populations.

SOURCES OF INFORMATION

This Science Advisory Report is from the December 4, 2012 review of the Assessment Protocol for Commercial Harvest of Pacific Oysters (*Crassostrea gigas*) in British Columbia. Additional publications from this meeting will be posted on the Fisheries and Oceans Canada (DFO) Science Advisory Schedule as they become available.

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